EEE141

Electrical Circuits I

Lecture-01

Instructor:

Md. Minhazul Islam

EEE, North South University

Email: minhaznirvik9a@gmail.com

Reference Textbook:

1.Fundamentals of Electric Circuits 6th ed.
By Charles K. Alexander and Matthew N.O. Sadiku

2.Introductory Circuit Analysis 11th ed.
By Robert L Boylestad

Charge

- Charge is an electrical property of the atomic particles
- Representation: q or Q
- Unit: Coulombs (C)
- Creation of Charge:

no of e^- = no. of p ⇒ neutral

(-)ve (+)ve

11 e^- = 10p

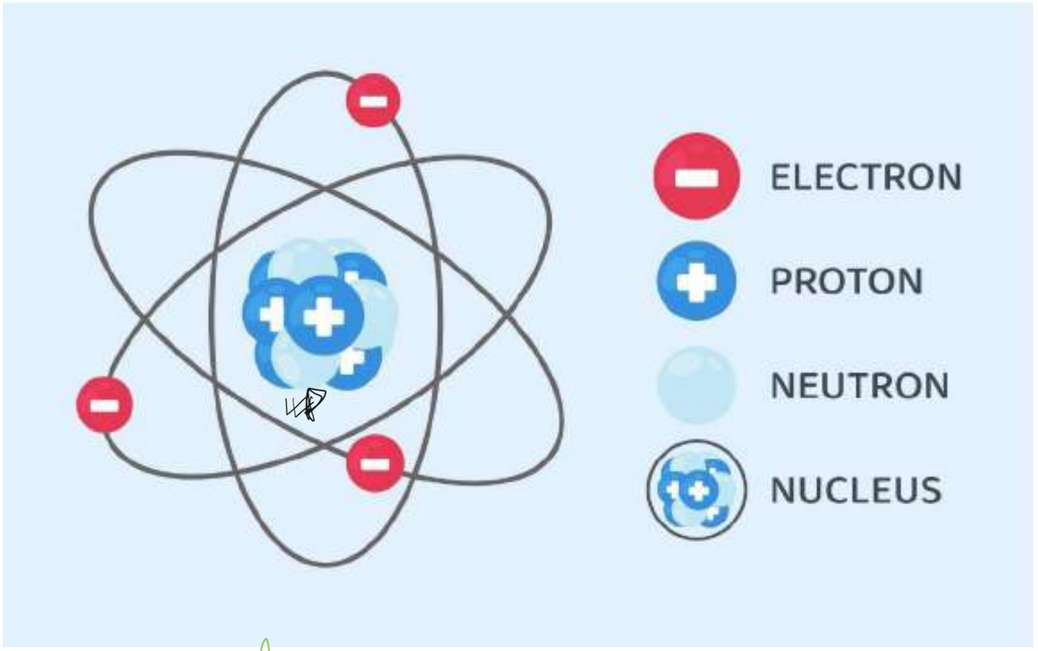
10 e^- = 10p

(-)ve

change of e^- ≠

- Electron's charge $1e^- = -1.6 \times 10^{-19}$ C
- Proton's charge $1p = +1.6 \times 10^{-19}$ C

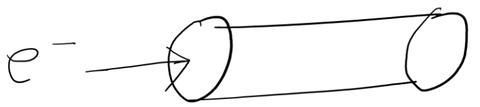
responsible for electricity e^-



(-)ve → e^- present

(+)ve → e^- absent

Current



- Current is the flow of electric charge through a conductor at per unit time.
- Also, rate of change of q w.r.t time

$$dt \longrightarrow dq$$

$$1 \longrightarrow \frac{dq}{dt} = I$$

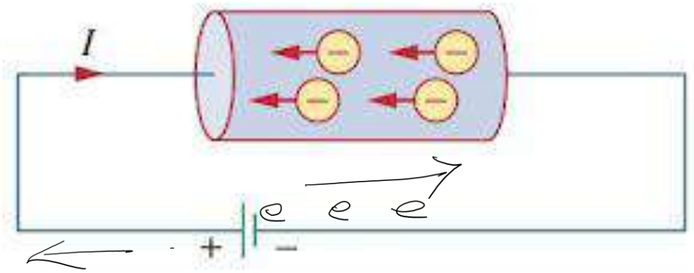
$$\int dq = \int I\,dt$$

$$\Rightarrow q = \int_{t_0}^{t} I\,dt$$

time function

$$\therefore I \equiv \frac{q}{t} \equiv \frac{C}{s} \equiv C\,s^{-1}$$

- Unit: Ampere (A)
- Direction:

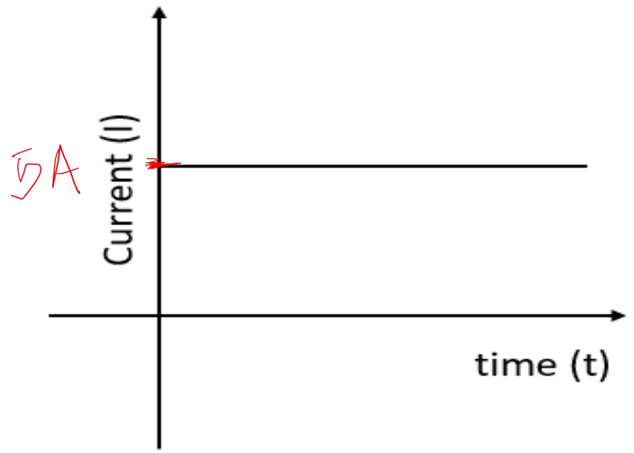


Battery

AC/DC

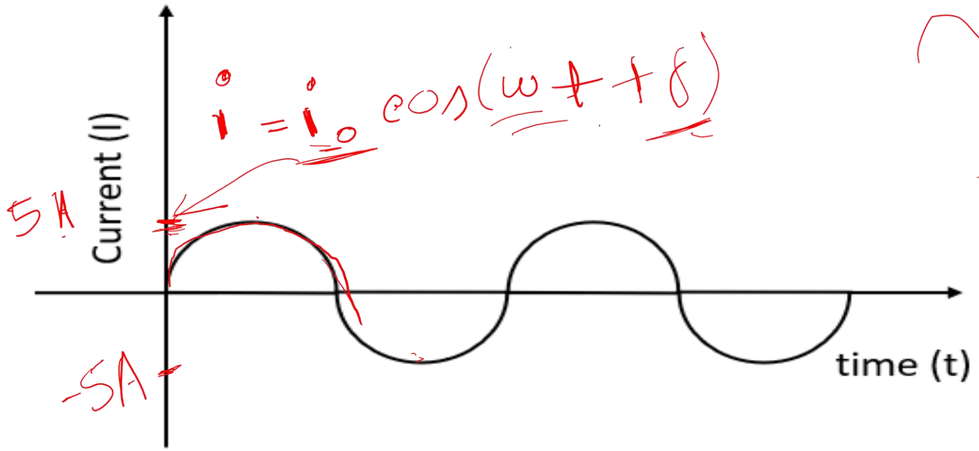
direction

- A direct current (dc) is a current that remains constant with time.



Direct Current

- An alternating current (ac) is a current that varies sinusoidally with time.



Alternating Current

rectify

✓ frequency dependent

Problems

1. The charge flowing through the imaginary surface is 0.16 C every 64 ms. Determine the current in amperes.

$$I = \frac{q}{t} = \frac{0.16\ C}{64\ ms} = \frac{0.16}{64 \times 10^{-3}}\ A$$

2. Determine the total charge entering a terminal between $t = 1$ s and $t = 2$ s if the current passing the terminal is $i = (3t^2 - t)$ A.

$$q = \int_1^2 i\,dt = \int_1^2 (3t^2 - t)\,dt$$

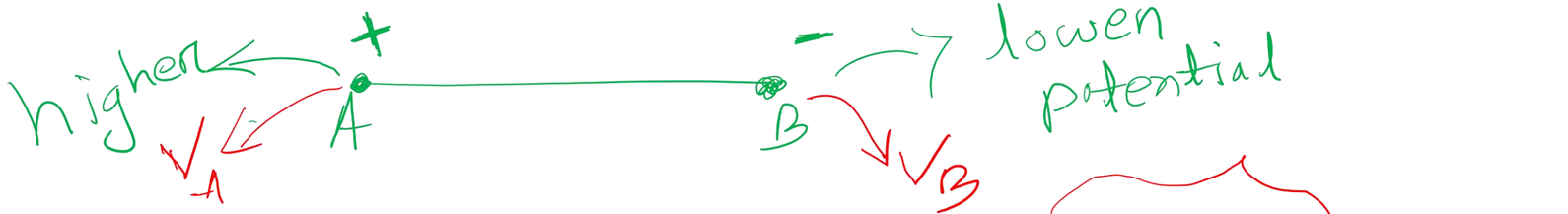
$$= 3\left[\frac{t^3}{3}\right]_1^2 - \left[\frac{t^2}{2}\right]_1^2 = (2^3 - 1^3) - \frac{1}{2}(2^2 - 1)\ C$$

Voltage (Potential Difference)

- Voltage is the energy required to move a unit charge through an element
- Unit: Volt(V) or J/C

$$dq \longrightarrow dW$$

$$\frac{dW}{dq} = V = \frac{W}{q} = \frac{J}{C} = \frac{J/C}{1}$$



Voltage difference, $\Delta V = V_A - V_B = V_{AB}$

- Voltage difference drives the flow of current between those points.

Problems

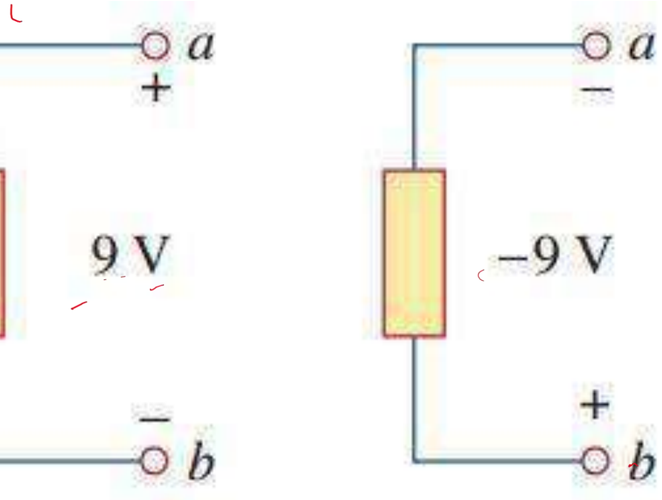
1. Find the voltage between two points if 60 J of energy are required to move a charge of 20 C between the two points.

$W = 60\ J$

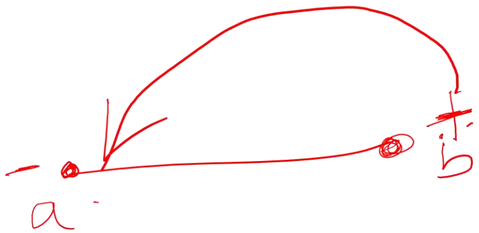
$q = 20\ C$

$V = \frac{W}{q} = \frac{60\ J}{20\ C} = 3\ V$

2.



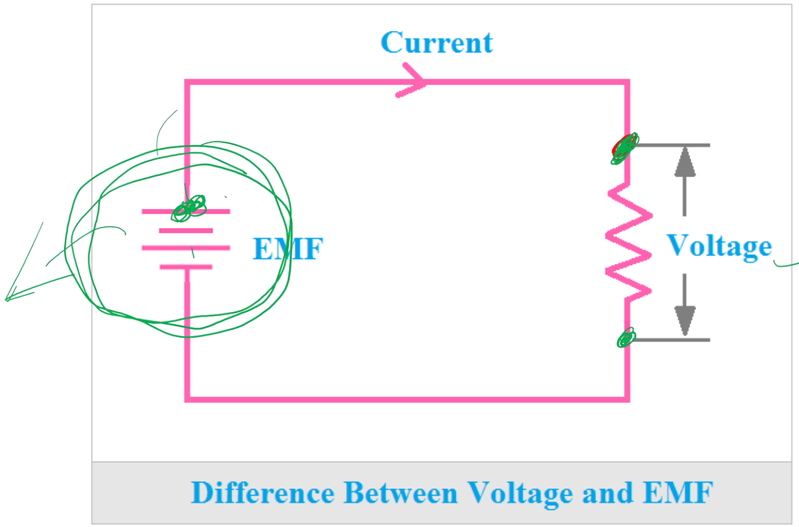
$V_{ab} = +9\ V$



$V_{ba} = -9\ V$

EMF

- EMF (Electromotive Force) is the energy supplied by a battery or generator per unit charge, measured in volts (V).
- It represents the potential difference when no current is flowing.



- Electric current is always through an element and that electric voltage is always across the element or between two points

Ampere-hour (Ah) rating

- Ampere-hour (Ah) rating measures a battery's capacity, indicating how much charge it can deliver over time. For example, a battery rated at 10 Ah can supply 10 amps for 1 hour, or 1 amp for 10 hours.

$$\text{Life (hours)} = \frac{\text{ampere-hour (Ah) rating}}{\text{amperes drawn (A)}}$$

20 Ah

20A → 1hr

1A → 20hr

- Prob.1 How long will a 9 V transistor battery with an ampere-hour rating of 500 mAh provide a current of 20 mA?

$$\text{Life} = \frac{Ah}{I} = \frac{500\,mAh}{20\,mA} = 25\,hr$$

Thank you!